

OCR A Level

Computer
Science

H446 – Paper 1



**Thinking
logically,
thinking
concurrently**

Unit 10

Computational
thinking



PG ONLINE

Objectives

- Identify the points where a decision has to be taken
- Determine the logical conditions that affect the outcome of a decision
- Determine how decisions affect flow through a program
- Determine which parts of a program can be tackled at the same time
- Determine the benefits and trade offs of concurrent processing

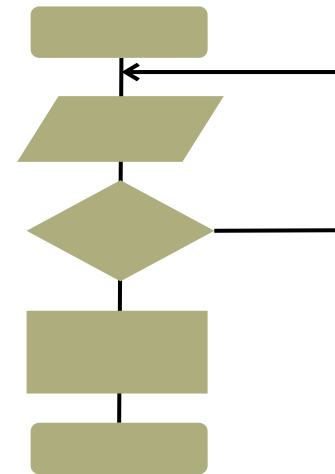
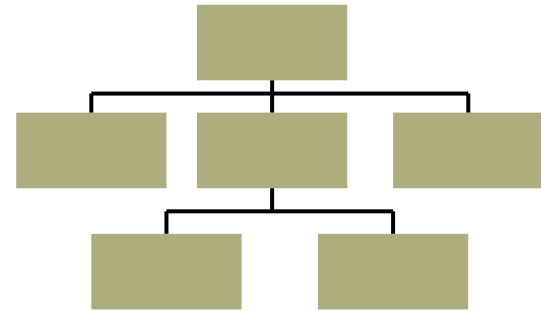
A good algorithm:

- has clear and precisely stated steps that produce the correct output for any set of valid inputs
- should allow for invalid inputs
- must always terminate at some point
- should execute efficiently, in as few steps as possible
- should be designed in such a way that other people will be able to understand it and modify it if necessary



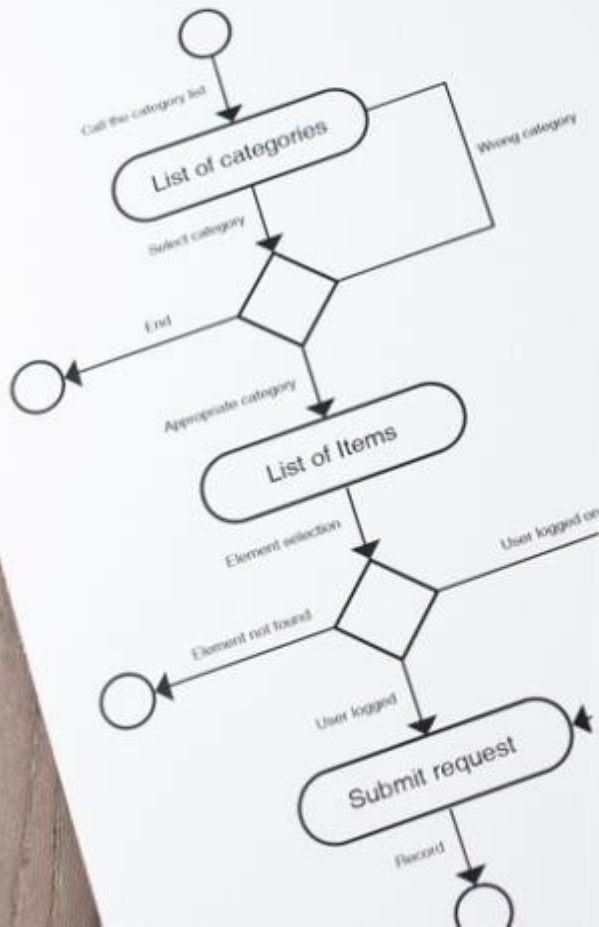
Tools for designing algorithms

- Hierarchy charts – useful for identifying the major task, and breaking these down into subtasks
- Flowcharts – useful for getting down initial ideas for individual subroutines
- Pseudocode – will translate easily into program code



Decisions, decisions

- Almost all algorithms involve decisions



Writing decision statements

- Decision or conditional statements include **IF** and **CASE** statements
- **WHILE**, **FOR** and **REPEAT** loops also implicitly involve decisions – the Boolean condition determines whether control will pass back to the beginning of the loop or continue with the next statement
- Probably the most common cause of logic errors in a program is a mistake in a conditional statement or a loop condition

Correct this code!

- The code below is intended to print out every third number in a list, starting with the first:

```
num = 0
while num <= len(listOfNumbers)
    print (listOfNumbers[num])
    num = num + 3
endwhile
```

- Will this work correctly?

Hand-tracing algorithms

- Hand-tracing is useful for:
 - Figuring out how an algorithm works
 - Finding out why an algorithm is not working properly
- A **trace table** is used to write down the contents of each variable as it changes during execution
- If the program contains a loop, a helpful technique is to put the loop condition as the first column in the trace table, even if other variables have been defined before it

Sample trace table

- What is output by the following algorithm?

```
n = 5
FOR count = 1 to n
    a = n - count
    b = 3 * a + count
ENDFOR
OUTPUT b
```

count	n	a	b
1	5	4	13
2	5	3	11
3			
4			
5			

- Complete the trace table to find out

Sample trace table

- What is output by the following algorithm?

```
n = 5
FOR count = 1 to n
    a = n - count
    b = 3 * a + count
ENDFOR
OUTPUT b
```

count	n	a	b
1	5	4	13
2	5	3	11
3	5	2	9
4	5	1	7
5	5	0	5

- Complete the trace table to find out **output is 5**

Worksheet 4

- Try **Task 1** on **Worksheet 4**



Decision points

- Suppose you are writing a program which gives a multiple choice test consisting of 10 questions, each with 4 possible answers
- At the end, the total number of correct answers is displayed
- Where are the points in the program where a decision has to be made?
- Write an algorithm for a solution to this problem

What is the longest river in the world?

- Amazon
- Mississippi
- Nile
- Yangtze

The algorithm

- Your algorithm may look something like this:

```
for i = 1 to 10
  display question and answers
  input answer
  compare with correct answer
  if answer is correct
    add 1 to total
  endif
endfor
display total
```

- There are two decision points in the program

Worksheet 4

- When complex Boolean conditions involving AND and OR are involved, it is easy to make mistakes
- Try **Task 2** on **Worksheet 4**

Validation routines

- Validation routines to check that a user has entered a value fit for processing can involve tricky Boolean conditions
- Routines to check that a password is correct also involve several decisions
 - What happens if the user enters an incorrect password?
 - How many tries are they allowed?
 - Will there be some way of giving them a reminder?
 - Will there be an option to click a “forgotten password” button to receive a new password by email?

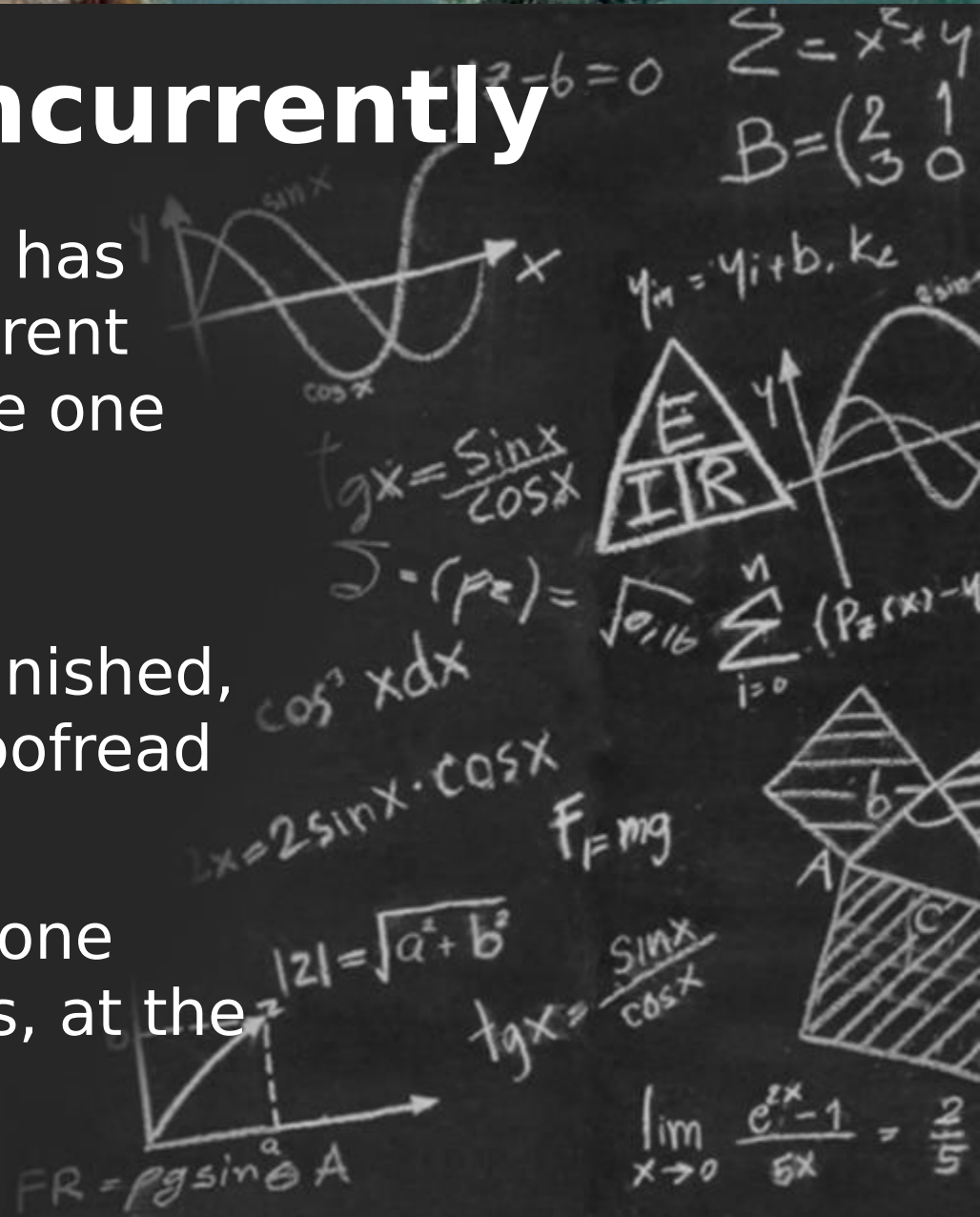
Worksheet 4

- Try **Task 3** on **Worksheet 4**



Thinking concurrently

- Suppose a publisher has contracted four different authors to each write one section of a Science textbook
- Each section, once finished, has to be edited, proofread and typeset
- What tasks can be done concurrently – that is, at the same time?



Thinking concurrently

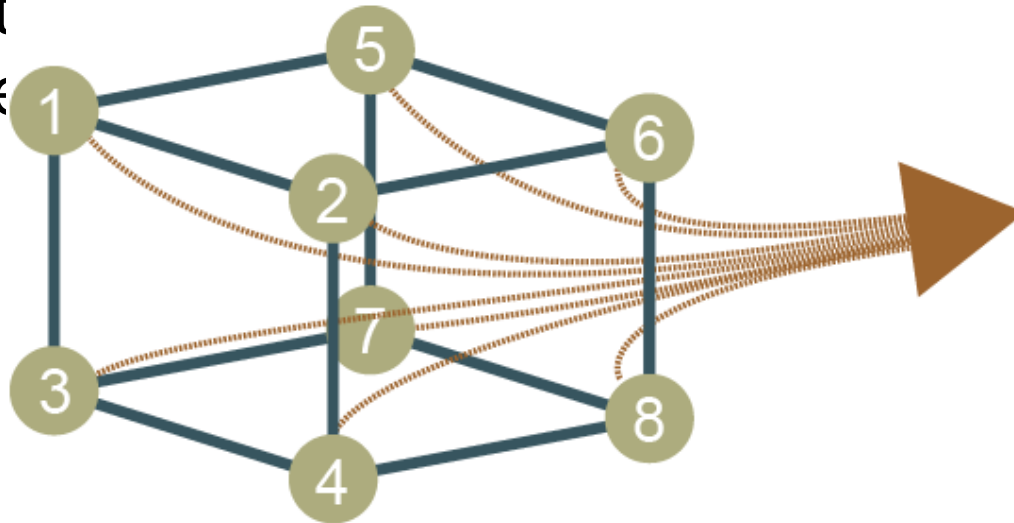
- What tasks involved in producing the book cannot be done concurrently?
- What are the benefits and trade-offs of having several people work on the book?

Concurrent processing

- In computing, concurrent processing means that multiple processors execute instructions simultaneously
- Tasks are broken down into sub-tasks that can be assigned to separate processors to perform simultaneously
 - The IBM Blue Gene supercomputer has 4,098 processors

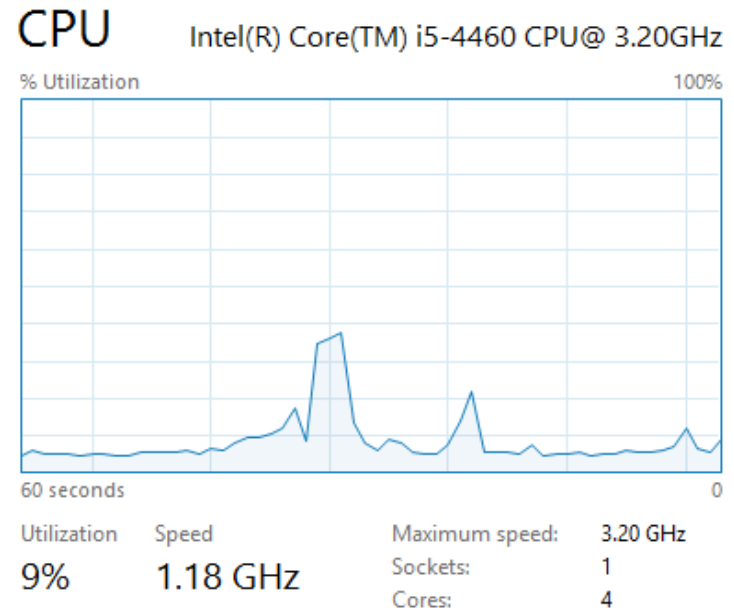
Numerical weather predictions

- Modern numerical weather forecasting methods require something between 10^{12} and 10^{16} computations to be carried out within 3-24 hours
- Special processors can process thousands of calculations simultaneously. How is this possible?



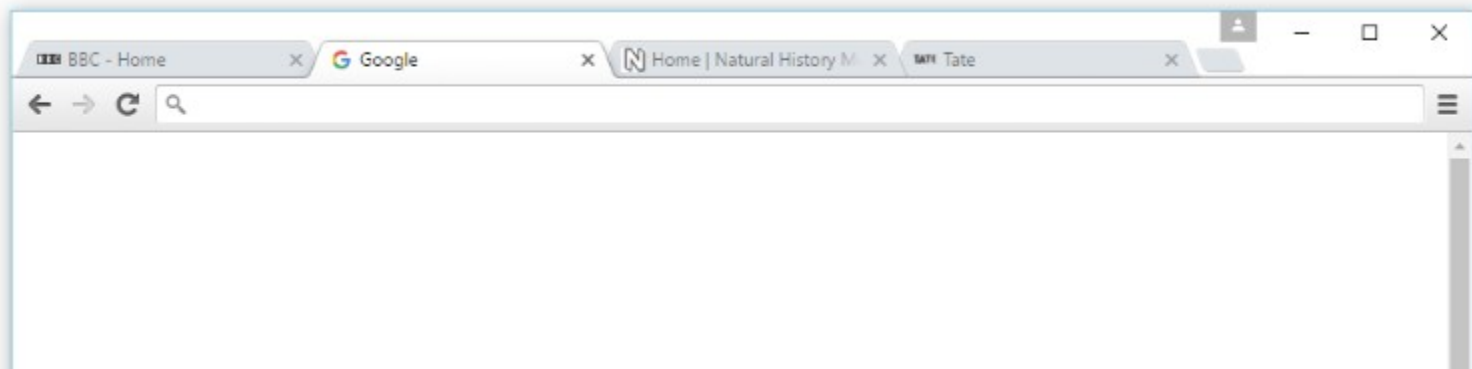
Dual-core and quad-core processors

- Many personal computers and mobile devices have 2,4 or more CPUs or 'cores'
- The operating system allocates separate tasks to different CPUs



Using multiple processors

- Google Chrome and Mozilla Firefox are capable of running several concurrent processes in a quad-core CPU
- This results in a much faster web browsing experience than on a single core CPU
 - In tabbed browsing, when multiple tabs are opened in a browser, all four cores may sometimes be operating at full capacity



Quad core processors

- Examples of concurrent processing on mobile devices include:
 - Video editing
 - Image processing
 - Facial recognition
 - 3D stereo games and applications
 - Virus scans

Concurrent processing in a network

- Concurrent processing is also used when several computers are joined in a network
- An airline reservation system is an example of concurrent processing



Plenary

- This lesson has covered two main topics:
 - Thinking logically
 - Thinking concurrently
- Virtually all programs have points where logical conditions determines the path taken
- Concurrent processing can take place when there are multiple processors in a single computing device
- The software has to be written in such a way that it can take advantage of multiple processors

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